claims 21-24 and 49-52. Thus no new matter has been added by these amendments.

Dependent claims also are amended to correct minor informalities and improve their language.

Claims 1, 2, 25 and 26 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Slater. Claims 1, 2, 17, 25 and 26 stand rejected under 35 U.S.C. § 102 (b) as being anticipated by Mravic. Claims 35 and 39 stand rejected under 35 U.S.C. § 102 (b) as being anticipated by Belanger. Claims 3-24 and 27-52 stand rejected under 35 U.S.C. § 103 (a) as being unpatentable over Mravic, Belanger or West, either alone or in view of one or more of the *ASM Handbook* (pages 121, 122, 710-716 and 802-813), Pichard, each other, or what is said to be common knowledge in the art.

Slater is said to disclose a copper based bullet formed by a powder metallurgical method.

Mravic is said to disclose a method of producing a lead-free bullet comprising pressing copper powder and sintering the pressed powder. Mravic further is said to disclose adding tungsten to the copper powder and using the bullet as ammunition. Also, Mravic is said to

disclose that the matrix metal can comprise copper, zinc and tin.

Belanger is said to disclose a powder mixture useful for manufacturing a frangible bullet comprising by weight 90% copper powder and molybdenum disulfide additive. Also, Belanger is said to disclose the use of stearate salts and molybdenum disulfide as lubricants when compressing copper powders.

West is said to disclose a powder for manufacturing a frangible bullet comprising 83 to 93% copper powder and a ceramic.

The *ASM Handbook* is said to disclose the use of a dispersion-strengthened copper with alumina for increasing the strength of a copper-formed article. The *ASM Handbook* also is said to disclose dispersion strengthening by inclusion of oxides, carbides and nitrides and to suggest boride as a ceramic equivalent thereto. Further, the *ASM Handbook* is said to disclose that ceramics useful in combination with metals include an oxide (Al_2O_3), a nitride (SiN), a carbide (TiC) and a boride (ZrB_2). Additionally, the *ASM Handbook* is said to disclose that copper mixtures containing tin and zinc can be pre-alloyed before use for the purpose of ensuring

continuity of mixture; and that copper alloy powders include brasses with a zinc content of 10-30% and bronzes with a tin content of about 10-15%.

Pichard is said to disclose that copper and copper alloys are equivalents in the forming of projectiles.

It is said to be common knowledge in the art to use graphite or MoS_2 to ease the release of compacted powder from a die, and in an amount of from 0.005 to 1% by weight in order to not impact the density of the sintered bullet. It is also said to be common knowledge in the art to repress a sintered compact for the purpose of increasing density.

These rejections are respectfully traversed in view of the following remarks which Applicants respectfully request the Examiner to consider in response to the Final Office Action.

Applicants' invention is a frangible bullet comprising a powder containing copper (either as a copper powder, copper alloy powder or a copper powder blended with another metal powder) and manufactured by pressing and sintering under conditions such as to produce a bullet that fragments upon impact with a target (claims 1-24). Applicants' invention also includes a

copper-containing powder useful in manufacturing a frangible item (claims 35-52), a method of making a frangible bullet comprising pressing and sintering a copper-containing powder under conditions to produce a bullet capable of fragmenting upon impact with a target (claims 26-34), and ammunition comprising the inventive bullet (claim 35).

In certain preferred embodiments of Applicants' invention, one or more additives comprising oxides, solid lubricants, nitrides, carbides and borides increase or decrease the frangibility and ductility of the bullet. In other preferred embodiments, frangibility and ductility are controlled by using a copper-containing powder and by regulating the pressure of the powder pressing, the sintering temperature, the sintering time, the sintering atmosphere, or by repressing or resintering the formed bullet.

The bullet of Applicants' invention is specifically designed to fragment upon impact with a target and comprises at least about 60% by weight copper.

It is respectfully submitted that none of the cited references, either alone or in any combination, discloses, suggests or otherwise renders unpatentable Applicants' invention as claimed.

Slater discloses a coated bullet having a metal core of sintered metal powder. In passing, Slater mentions that the metal core may be selected from a group comprising, *inter alia*, copper and bronze powders. However, there is no disclosure whatsoever in Slater as to the way and manner by which a frangible, predominantly copper bullet might be achieved. The teachings of Slater are directed to a sintered iron core bullet and provide no direction or guidance and are non-enabling as to the use of any other metal.

Slater discloses sintering at temperatures in the range of 650-750°C and that higher temperatures produce **non**-frangible bullets (see page 3, lines 1-6). Slater also discloses sintering times of about 1 to 5 hours. Further, Slater does not teach any amount of copper or bronze, or additives, to be used in the bullet and teaches only that the density of the bullet should be at minimum about 6 gm/cm^3.

Applicants have found that to produce a frangible, predominantly copper bullet, the sintering temperature preferably is between about 1500 to about 1900°F (815 to 1040°C) and that the sintering time preferably is between about 10 to about 120 minutes, more preferably between about 15 and 45 minutes.

Further, Applicants have found that the frangible bullet preferably comprises at least 60% copper.

The sintering temperature, sintering time, composition and density of the bullet all effect the balance between dimensional tolerances, frangibility, ductility, cost, ricochet and target backstop damage that Applicant's invention achieves. Slater's silence on these factors leaves one skilled in the art without an instructional clue as to how a frangible predominantly copper bullet might successfully be made. Slater's passing reference to copper and bronze powders is a mere idea that, at best, one is invited to try.

Further, it is respectfully submitted that, if one were to attempt to try the methods limitly disclosed by Slater to manufacture a predominantly copper bullet, the result would not be a frangible bullet of the present claims.

Most telling is that Slater requires a plastic or metal coating for its bullet. The coating is required for, among other reasons, "maintaining the integrity of the projectile during the firing cycle. . ." (page 3, lines 28-29). A coating or jacket on a bullet, however, is also dangerous as it tends to ricochet back from the target like shrapnel, causing severe cuts to a shooter.

No coating is required for Applicants' inventive bullet (though one may employ a coating for cosmetic or other reasons) as Applicants have discovered the means for making a frangible bullet that also has sufficient ductility to withstand the firing operation. Slater, it is respectfully submitted, does not disclose such means, even for iron bullets, let alone predominantly copper bullets.

Consequently, it is respectfully submitted that Slater neither discloses nor suggests a frangible copper bullet of the presently claimed invention. Slater especially does not disclose an operable bullet comprising at least about 60% copper.

Accordingly, it is respectfully requested that the rejection under 35 U.S.C. § 102 as being anticipated by Slater be reconsidered and withdrawn.

Mravic does not cure the omissions of Slater. Mravic is concerned with a sintered composite bullet having as its major constituent a high-density metal powder and as its minor constituent a lower-density matrix material. This bullet, it is said,

> "stems from the understanding that ferrotungsten and other high-density, tungsten-

containing materials listed are not only economically feasible for bullets, but that they can, by an especially thorough metallurgical and ballistic analysis, be alloyed in proper amounts under proper conditions to become useful as lead free bullets."

Column 2, lines 46-52. Thus, Mravic's disclosure is directed and limited to the making of bullets of predominantly high-density, tungsten materials. As with Slater, Mravic teaches sintering conditions useful for the making of bullets which are <u>NOT</u> predominantly copper and is of no aid or assistance to the making of a predominantly copper bullet.

According to Mravic, there are six requirements for a successful bullet (see column 3, line 15 to column 4, line 10) all of which are effected by sintering conditions and the composition and density of the resultant bullet. For instance, too low a density may make a bullet too weak and prone to fragment during the firing process. Too high a density may cause swelling during sintering, making dimensional control difficult, and also may make the bullet too strong and not adequately frangible. Too low or high a sintering temperature or too short or long a sintering time may result in a bullet too weak to survive the firing process or too strong to sufficiently fragment upon hitting a target.

Mravic does not suggest, let alone teach, that its disclosed methods are at all applicable to producing a predominantly copper bullet. Indeed, Mravic specifically countenances, at column 2, lines 60-62, that the

> "complex requirements on a bullet make accurate theoretical prediction virtually impossible."

In the bullets of Mravic, copper (or plastic or other light density matrix material) is the minor constituent. The copper-containing bullets in the Examples of Mravic contain no more than 15 or 28% copper. And there is no suggestion or motivation to increase the copper content, especially not to become the predominate constituent. Mravic expressly teaches that the predominate constituent must be a high-density tungsten material.

Further, Mravic does not disclose or teach a frangible bullet having a ductility sufficient to withstand the firing operation without fragmenting upon being fired as is accomplished by Applicants' invention. At column 3, line 64 to column 4, line 4, Mravic expressly teaches that its bullets "must be coated with metal or plastic or jacketed" to protect the barrel and to ensure that the bullet remains intact as it passes through the barrel after being fired.

Mravic also specifically discloses that the bullet have a density of at least 9 g/cm^3 (column 2, lines 33-34), or approximately the same as lead, 11.3 g/cm^3 (column 3, lines 33-36). Densities significantly less than that of lead bullets are considered a drawback (column 1, lines 49-51). Thus, Mravic teaches away from bullets made from predominately copper, as such would almost always have density less than about 9 g/cm^3; preferably, about 7.5 to about 8.5 g/cm^3.

Accordingly, it is respectfully submitted that Mravic neither discloses nor suggests a frangible bullet of the presently claimed invention. Mravic particularly does not disclose or suggest a bullet that does not require a jacket or coating and comprises at least about 60% copper.

Accordingly, it is respectfully requested that the rejection under 35 U.S.C. § 102 as being anticipated by Mravic be reconsidered and withdrawn.

Mravic discloses adding together tungsten carbide and copper powder (and zinc and tin to be functional equivalents to copper as low-density matrix metal constituents) in its composite metal bullets which may be used as ammunition. However, such disclosure does not fill the

basic omissions of Mravic to disclose a frangible predominately copper bullet.

Further, as previously discussed, tungsten carbide (or tungsten or other tungsten alloy) is the major constituent in the bullets of Mravic. It is the major constituent because it imparts high density to the bullet. Tungsten content cannot be greatly reduced, certainly not to the point it becomes a minor constituent, as such will defeat the objective of a high density bullet.

In contrast, Applicants employ in certain embodiments of their invention a minor amount (preferably 0.5 to 1.0 percent by weight) of tungsten carbide. This use of a minor amount of tungsten carbide has been found by Applicants to increase the frangibility of copper (see page 9, lines 12-13 of the instant specification).

It is respectfully submitted that the use of a minor amount of tungsten carbide in a predominantly copper bullet is not disclosed or suggested by Mravic in any manner, let alone for increasing copper frangibility. In fact, Mravic's central aim of increasing the density of a bullet through increasing amounts of tungsten and/or tungsten compounds necessarily teaches away from the use of minor amounts of tungsten carbide to achieve a central aim of the instant invention, which is to maximize frangibility upon contact with the bullet's target. On the face of

it, a preferred embodiment of Applicants' invention and Mravic's would appear to be identical in constituent parts: both call for copper and tungsten (and/or tungsten compounds) in the bullet; however, the similarity ends when the relationship between their respective parts is closely examined. The respective ratios of constituent parts of both inventions are diametrically opposed.

Thus, it is respectfully requested that the rejection of claims including tungsten carbide as an additive as being anticipated by Mravic be reconsidered and withdrawn.

As with Slater and Mravic, Belanger neither discloses nor suggests a frangible bullet of Applicants' invention. Belanger is concerned with a frangible bullet consisting of a compacted mixture of 90 to 93.5% copper with nylon binder. The bullet is formed by injection molding <u>not</u> pressing in a die and sintering.

Belanger does not disclose or suggest that its compacted mixture is useful to manufacture a frangible item by sintering. Belanger only discloses injection molding.

In injection molding, the pressures used are low and the nylon resin binds the copper particles together. No deformation of the copper particles takes place, no sintering is done, and

no metallurgical bonding occurs. Consequently, the densities are low (5.7 g/cm^3) and the bullets do not adequately simulate lead ammunition.

Belanger discloses the use of MoS_2, but only as a lubricant to aid die release in the injection molding operation. It does not disclose or suggest that MoS_2 is useful to increase the frangibility of sintered copper items, as found by Applicants.

Here again, as with Mravic, if the presence of an identical element or compound in one invention is repeated in a subsequent invention, it is not enough to claim anticipation of one invention by another. For it is the relationship of that element to other constituent parts in the invention which is crucial in determining originality and anticipation. Both Belanger and the instant invention surely share the same compound, but the relationship of that compound to the processes of both inventions is entirely different. In Belanger, the compound is related to injection molding, whereas in Applicants' invention it is a component in sintering. The same compound which increases lubrication in Belanger increases frangibility in the instant invention. The use of the compound in both inventions, therefore, is diametrically opposed: in the one it facilitates sliding, while in the other, breaking of bonds.

Not only is there no instruction or motivation provided by Belanger to use its compacted mixture, with or without MoS_2, to manufacture a frangible item by sintering (as called for in Applicants' invention), it is respectfully submitted that one skilled in the art would not even entertain the thought of sintering Belanger's compacted mixture. Nylon has a relatively low density (1.02 g/cm^3) and thus at even a 6.5% weight concentration its volume is considerable in the mixture. Therefore, there is little, if any, direct contact between copper particles (which is desired for the nylon to bind the copper particles together). If sintered, the nylon would burn off and the copper particles, not having been compacted directly together before sintering, would not bind sufficiently to each other. The resultant sintered product would have a very low density and simply would crumble apart.

Accordingly, it is respectfully requested that the rejection of claims as being anticipated by Belanger be reconsidered and withdrawn.

It is further respectfully submitted that none of the secondary references alone or together, cure the deficiencies of the primary references.

West is directed to an improvement in the frangible bullet disclosed by Belanger in which

Belanger's nylon binder is replaced by a polyester binder having a higher density (1.30 g/cm^3) and an ionomer resin. Like Belanger, West neither discloses nor suggests that its compacted mixture is useful to manufacture a frangible item by pressing and sintering. And, like Belanger, West only discloses injection molding.

West discloses that a "ceramic" may be used in additive to or instead of copper powder. However, this ceramic is not identified and the purpose of its use is not mentioned.

Thus, West adds nothing to the primary references' disclosures regarding a frangible, predominantly copper bullet manufactured by pressing and sintering a powder containing copper, a copper containing powder useful in manufacturing a frangible item by pressing and sintering, or a method of making a frangible bullet comprising pressing and sintering a copper-containing powder as claimed by Applicants.

The *ASM Handbook* discloses the use of oxides, carbides, nitrides and borides for the purpose of increasing the strength of a metallic article. The dispersion strengthened materials and cermets described in the *ASM Handbook* are near fully dense materials in contrast with the lower density, porous bullets of Applicants' claimed invention. In such dense materials the

additives are described as increasing their strength. There is no disclosure or suggestion in the *ASM Handbook* to use such additives in low density, porous materials, let alone that the use of some would actually increase the frangibility of the resultant product as discovered by Applicants.

The *ASM Handbook* also discloses that copper mixtures containing tin and zinc can be pre-alloyed. However, the *ASM Handbook* does not teach whether the presence of tin or zinc will effect the frangibility of a predominantly copper sintered bullet. Surprisingly, both bronze and brass have been found by Applicants to be highly frangible.

Therefore, it is respectfully submitted that the *ASM Handbook* also provides no additional guidance to the skilled artisan in the composition or manufacture of a frangible bullet by pressing and sintering a copper-containing powder.

Pichard discloses a projectile of novel design. Copper, or alloys thereof, among other metals are said to be useable as filler materials in a resinous matrix bullet formed by molding. Like both Belanger and West, there is no disclosure or suggestion of forming a bullet by pressing and sintering. Thus, Pichard, it is respectfully submitted, adds nothing respecting adaption of

the primary references's disclosures to in some manner arrive at Applicants' claimed invention.

Finally, while it might be common knowledge to one skilled in the art to use lubricants to ease the release of a compacted powder from a die, it is not common knowledge that adding solid lubricants effects the frangibility of sintered copper bullets as has been discovered by Applicants.

Accordingly, it is respectfully submitted that none of the cited references, either alone, or in any combination, discloses, suggests or otherwise renders Applicants' claimed invention unpatentable.

Wherefore, it is respectfully requested that the amendments be considered and entered, the rejections be reconsidered and withdrawn, and the application be allowed and passed to prompt issuance.

Alternatively, it is respectfully requested that the amendments to be entered as placing the application in better form for possible appeal.

If it would be helpful in advancing this application to issuance, the Examiner is